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Coupling δ^{18}O values of rodent tooth and mollusc shell carbonates: a new approach to reconstructing Pleistocene palaeotemperatures?

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The ratio of stable oxygen isotopes in fossil rodent teeth ($\delta^{18}O_{rt}$) can potentially provide valuable quantitative information about terrestrial palaeoclimate conditions. Grimes et al. (2004) suggested that $\delta^{18}O_{rt}$ could be usefully combined with the δ^{18}O values of coeval biominerals, e.g. mollusc shells ($\delta^{18}O_{ms}$), to estimate past summer temperatures during the Quaternary period. Nevertheless, until now, the application of this approach to Quaternary palaeoclimate reconstruction has remained unexplored. In addition, the success of this approach is dependent upon the establishment of a statistically robust relationship between $\delta^{18}O_{rt}$ and the δ^{18}O of meteoric water ($\delta^{18}O_{mw}$) in the modern environment. However, such a relationship is yet to be quantified in relation to rodent tooth carbonate.

Here, we present the preliminary results of 2 studies investigating the validity of $\delta^{18}O_{rt}$ as a climate proxy. Firstly, isotope analyses were undertaken on modern vole (Microtus agrestis) teeth from 3 locations across the UK. The results of these analyses reveal a significant linear correlation between the mean $\delta^{18}O_{rt}$ and the mean $\delta^{18}O_{mw}$. These findings therefore demonstrate that a quantifiable relationship exists between $\delta^{18}O_{rt}$ and $\delta^{18}O_{mw}$, highlighting the potential of $\delta^{18}O_{rt}$ as an accurate recorder of local climatic conditions.

This modern relationship was subsequently applied to the reconstruction of past $\delta^{18}O_{mw}$ values for two Pleistocene interglacial sites in the UK. The $\delta^{18}O_{mw}$ values were calculated using $\delta^{18}O_{rt}$, and then combined with $\delta^{18}O_{ms}$ values derived from coeval fossil gastropod assemblages in order to estimate mean summer palaeotemperatures. The results of these calculations are in close agreement with multi-proxy temperature reconstructions derived from the same deposits. This suggests that coupling the δ^{18}O values of rodent tooth and mollusc shell carbonates offers great potential as an approach to quantifying summer palaeotemperatures in Europe, particularly for carbonate-rich sites at which alternative temperature proxies may be unavailable.

References:
Grimes, S.T., Mattey, D.P., Collinson, M.E. & Hooker, J.J. (2004) Using mammal tooth phosphate with freshwater carbonate and phosphate palaeoproxies to obtain mean paleotemperatures. Quaternary Science Reviews, 23, pp.967–976.